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Popping up graphene oxide for capacitive applications

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Abstract

Single layer graphene exhibits a theoretical specific surface area as high as 2630 m^2 g^{-1} and has an intrinsic capacitance around 21 µF cm^{-2}, making it excellent candidate for electrochemical capacitor applications. However, a major challenge in the field of energy storage devices by adopting graphene as electrode materials still remains to achieve highly porous structures with good quality in large scale production, because single layer graphene must be collected into various assemblies, in which the restacking due to the strong sheet-sheet van der Waals interactions is unavoidable. Thermal-related exfoliation production of graphene has been believed to be a promising strategy for practical applications, but the needed high temperature and special experimental environment hinder this method from wide adoption. In this study, an actuation triggered thermal exfoliation process is realized at a very low temperature of 200 ^oC and atmospheric pressure. The underlying mechanism is found to be similar to corn popping and attributed to the thermally-stimulated actuation and water molecules escape. It is found that after the exfoliation process, the resultant popped graphene oxide exhibits highly porous structures with the oxygen-containing groups being effectively removed, and has a specific capacitance of 120 F g^{-1} without any retention after 1500 CV cycles, demonstrating good electrochemical capacitance performance with excellent stability. The popping-like process can effectively reduce graphene oxide into 3D porous geaphene structures in one single-step process. This process is mild, short in time, environmental friendly and most importantly providing a scalable and easy method to produce large amount graphene-based assembly for potential capacitor applications.